PLATE LIV.

The figures on this Plate are semi-diagrammatic.

Acanthephyra debilis A. M.-Edw.

Fig. 1. A longitudinal section of a photophore from the protopodite of a pleopod. The cellular layer (*c.*), which is apparently derived from the epithelium, is composed of long cells with densely staining nuclei at their outer ends. The only cytoplasm which is visible lies between the nuclei and the inner face of the lens. × 210. (Compare fig. 1, Pl. LII.)

Sergestes challengeri Hansen.

Fig. 2. A longitudinal section of the eye-stalk showing the photophore (*ph.*) lying close to the eye (*e.*) and separated from it by a curtain of black pigment (*p.*). × 160.

3. A photophore from the penultimate joint of the second maxillipede in transverse section. × 380. (Compare fig. 3, Pl. LIII.)

4. A transverse section of the branchial chamber showing an arthrobranch (*a.*) and one of the four photophores (*ph.*) which are set in the roof of the cavity and appear to illuminate the gills from above. × 44.

5. The same photophore on a larger scale. The two layers of the lens (*i.l.* and *o.l.*) and the first cellular layer (*c.'*) are formed from the cuticular and epithelial layers of the inner surface of the branchiostegite. × 380.

Reference letters :—

a. Arthrobranch.
b. Branchiostegite.
c. Cellular layer (in *Acanthephyra*.)
c'. First cellular layer (in *Sergestes*.)
c''. Second cellular layer (in *Sergestes*).
e. Eye.
e.l. Epithelial cell-layer.
g. Cone of minute highly refractive granules in close connection with nerve-strand.
i.c. Inner cuticular layer of branchiostegite.
i.l. Inner layer of lens.
m.l. Middle layer of lens.
n. Nerve.
o. Optic ganglia.
o.c. Outer cuticular layer of branchiostegite.
o.l. Outer layer of lens.
p. Curtain of black pigment between photophore and eye.
ph. Photophore.
r. Reflector or striated layer.
s.l. Sheathing layer of cells.

2. On the Varieties of *Mus rattus* in Egypt; with General Notes on the Species having reference to Variation and Heredity. By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S.

[Received December 22, 1909.]

(Text-figures 58–62.)

While spending a few months recently at the Giza Zoological Gardens, near Cairo, I was enabled through the kindness of the Director, Capt. S. S. Flower, to examine a large number of the common House Rats of the district. I gladly took advantage of the opportunities thus offered, as I was convinced that a close study of this species would throw some light both on the causes of variation and on the inheritance of the varieties that are found in such profusion in *Mus rattus*.

In addition to the rats which were caught in the Gardens, Dr. Charles Todd, of the Public Health Department, kindly allowed me to examine and measure all the rats that came into his hands during the time that I was in Cairo. These rats were taken in various towns and villages in the Delta by special catchers employed by the Public Health Department, the result being that some 500 rats in all were carefully examined and measured in the flesh.

Before detailing the results of this examination it may perhaps be as well to review roughly the status and problems concerning this species, which is best known in this country as the "Old English Black Rat." *Mus rattus* is by far the commonest "ship-rat" and has thus become practically cosmopolitan in its distribution, but when it comes in contact with *Mus norvegicus* *, our common rat, a larger, stronger and more pugnacious species, it has to give way, and owing to this fact it is now extremely scarce in England.

In the East (India and the Malay States) *Mus rattus* is still holding its own, although in those localities *M. norvegicus* is gradually increasing, and in Egypt, while still very abundant and in some places the only house-rat, it is slowly but surely being superseded by the larger and stronger species.

The ready variability of *Mus rattus* together with the continual crossing of different forms due to the importation of foreign varieties on ships, has given rise to such a mass of variation, that the work of the systematist has been rendered very difficult.

The actual localities from which my specimens came were Ath, Damanhour, Abu Homos, Giza, Fayûm, Foueh, and Cairo. In all except the last two both *M. rattus* and *M. norvegicus* were found in about equal numbers; at Foueh, however, out of 80 rats only three were *M. norvegicus*. From Cairo itself I did not see many rats, but all those met with were *M. rattus*; and Capt. Flower tells me that *M. norvegicus* is not yet known there. As regards the Giza Gardens, which lie on the opposite side of the river to Cairo, the latter species has only appeared within the last eight years and forms now about 30 per cent. of the rats there. It has entirely ousted the field-rat (*Arvicanthis*) which used to abound in the Gardens.

As regards the proportions of the sexes, both *M. norvegicus* and the two forms of *M. rattus* show a slight excess of females, the actual figures being as follows:—

Percentage of males in	*M. norvegicus*...............	42 °/₀
,, ,,	*M. r. tectorum*	44 °/₀
,, ,,	*M. r. alexandrinus*	50 °/₀.

The higher percentage of females in *M. norvegicus*, if always present, would tend, apart from other reasons, to cause a higher rate of increase of this species at the expense of other species.

In both species there is practically no difference in the size of the sexes, but the males have a wider range of variation.

Thus we have in

M. norvegicus	♂'s,	hind foot 28–43 mm.,	♀'s 30–44 mm.
M. rattus	♂'s,	,, 26–38 mm.,	♀'s 29–38 mm.

* *Mus norvegicus* Erxl. antedates *Mus decumanus* Pall. by which this species is better known.

Mus rattus *in the Indian Region.*

In the Indian Region in particular this species has been burdened with a tremendous number of specific names, given to any variety which did not appear to fit in with the existing descriptions; and with a view of partially clearing up this tangle of names, I went into the matter at some length a few years back *.

Briefly summed up my conclusions were as follows:—

If the large towns and seaports, where the rat population is apparently as cosmopolitan as the human, are put out of consideration it appears:—

(i.) That in most localities three fairly distinct forms are found;

(ii.) That in any particular locality individuals belonging to the same form do not show much variation and intermediates between the forms are comparatively scarce;

(iii.) In most localities the same three forms are easily recognisable though differing slightly from their corresponding varieties in other places.

I, therefore, divided the species into three subgroups, representing the three forms, and distinguished them as follows:—

(i.) *Jalorensis* † subgroup.
Hairs of underparts white to their bases. Hind foot 30 mm.

(ii.) *Rufescens* subgroup.
Hairs of underparts white with slate-coloured bases. Hind foot 33 mm.

(iii.) *Griseiventer* subgroup.
Hairs of underparts entirely slate-coloured or tipped with fulvous. Hind foot 35 mm.

In addition to the characters given above, the subgroups appeared, from collectors' notes, to have slightly different habits, the last-named being found chiefly in houses, *Jalorensis* in the hilly districts, and *Rufescens* in the date-palms.

On this plan, it became comparatively easy by careful reference to original descriptions and specimens to refer almost all the varieties which had been described, to one or other of the subgroups, and then, by noting the type locality of each variety, the mass of names became reduced to a manageable and fairly logical order. Where two descriptions had been applied to rats from the same locality, it was in most cases at once obvious from those descriptions that they were not synonyms but referred to individuals of different subgroups.

Without more material I did not feel justified in making further comment, but left the work as a foundation to be improved and elaborated should a future opportunity arise.

In 1907, in the Mem. Ind. Mus. i. no. 1, Dr. Hossack has

* 'Fasciculi Malayenses,' i. Zool. pp. 28 *et seqq.* (1903).

† I named the subgroups, not after the oldest species but after the one of which the original description would leave least doubt as to the main characters of the subgroup.

criticised my paper and comes to the conclusion that my effort has not cleared up the confusion and that all these rats belong to one and the same species—*Mus rattus*.

Dr. Hossack's remarks, fair and just as they appear to be, fail from the fact that we were working at the subject from entirely different points of view—he as a medical man, anxious to know the number of species by which the plague might be conveyed—I, as a zoologist, seeking for a law and order in the apparently innumerable varieties found among these rats. For Dr. Hossack's purpose it is sufficient to know that there are but two species of true rats, usually found in houses—the short-tailed, heavy-built and practically invariable *Mus norvegicus*, and the long, slender, and extremely variable *Mus rattus*, which includes *all* the varieties bearing the mass of names that so confused my critic. Had he written to me in the first place, I could have told him at once that all these long-tailed rats belonged to one very variable species, and that in the large towns, where all his material was procured, no order or classification was possible as the varieties had become hopelessly mixed and crossed, but that in the country places the varieties were much better defined, and apparently bred true. The question of the classification and study of these varieties is a specialised study for zoologists, and it is not to be expected that a medical man, studying the plague, should be able to devote the time necessary for the thrashing out of such matters.

It would therefore have been better had he applied to recognised authorities for his information, rather than attempt a task in a specialised subject outside the scope of his investigations.

I am glad to have had this opportunity of replying to Dr. Hossack, for many people do not yet realize that the study of geographical forms and minute variations has a very great bearing on many large and important zoological problems, but need not concern the man engaged on other cognate investigations, and in the present instance it is sufficient for him to know that all these varieties of the long-tailed rat belong to one species, *Mus rattus*.

Mus rattus *in Egypt*.

In Egypt we find two distinct forms of *Mus rattus*—the one with pure white underparts and white feet, which was named *Mus tectorum** by Savi; and the other with slate-grey underparts and dark feet, which may be known as *Mus alexandrinus*†. Between these two forms many intermediates occur, the actual typical forms being comparatively rare‡.

* *Mus tectorum* Savi, Nuovo Giorn. Pisa, 1825.

† *Mus alexandrinus* Geoff. Descr. de l'Egypte, Hist. Nat. ii. p. 733; Atlas, pl. v. fig. 1 (1812).

‡ This statement apparently contradicts the remarks on p. 653, but it must be borne in mind that those remarks were based on Malay material, obtained in centres removed from the influence of foreign shipping, whereas in the present case the specimens came from populous centres, contiguous to a large waterway (the Nile and its branches).

I have already referred to the fact that in India the three varieties of *M. rattus* may roughly be considered as hill, tree, and house forms; but in Egypt, where the cultivated parts frequented by these rats are low-lying and level plains, only two forms were found.

I made a number of careful observations in the Giza Gardens, where both forms are found, to see whether the two varieties were really different in their habits, but such evidence as I was able to get together was very inconclusive. Large numbers of plane trees grow in the Gardens and on these, often at a considerable height from the ground, many heaps of the fruit, looking not unlike squirrels' dreys, were to be found. These were undoubtedly brought together by rats, but investigation proved that they were used merely as convenient platforms on which to feed, and *not* as sleeping or breeding places. The seeds of these trees are apparently a favourite food, and as it would be impossible for a rat to devour them *in situ*, they are picked and carried to the first convenient spot, generally a fork near the main trunk, to be devoured, and it is on such places that the accumulated débris forms the apparent nests. On the other hand, the fruit which had fallen to the ground was frequently taken into a neighbouring bush and eaten there, so that there is undoubtedly a tendency to an arboreal life.

On two occasions only did I actually see a rat in a tree, and neither time were they accurately identified, although one, I am almost certain, belonged to the white-bellied form (*M. tectorum*). Both forms were found living in burrows in the ground as well as in the houses, so that there seems to be but little difference in habits between the two varieties. The apparent absence of the third (Indian) subgroup, however, taken in correlation with the lack of high ground, seems certainly suggestive, but I shall have more to say on this point later.

In studying the various forms of *Mus rattus* I found it convenient to classify them into four groups.

(i.) *The Typical Tectorum*, in which the hairs of the underparts are white to their bases and the upper surface of the hind feet is also white.

(ii.) *The Grey Tectorum*, in which the hairs of the underparts are white to their bases but the upper surface of the hind feet shows traces of brown.

(iii.) *The Grey Alexandrinus*, in which the hairs of the underparts have slate-coloured bases and the upper surface of the hind feet shows much brown.

(iv.) *The Typical Alexandrinus*, in which the hairs of the underparts are slate-coloured throughout or nearly so, and the hind feet entirely brown on the upper surface.

In actual shade of colour much variation was shown. Groups (iii.) and (iv.) were constantly darker than groups (i.) and (ii.), but in classifying them, reliance was only placed on the characters noted above, which allowed no possibility of doubt.

[*Mus norvegicus*, on the other hand, proved very constant and no variation in colour was noticeable. In this species, the hairs of the underparts have slate-grey bases and the upper surface of the hind feet is pure white, a combination of characters apparently not found in *M. rattus* from Egypt.

Apart from this distinction, *M. norvegicus* is a larger and more stoutly built animal; the length of the tail *never* exceeds that of the head and body, and the ears are shorter and more rounded. There are also some easily recognisable skull differences, which need not be gone into here.]

Every specimen was carefully measured in the flesh by myself with the same callipers, so that errors from a comparison of measurements are reduced to a minimum. The measurements taken were: snout to root of tail, tail, hind foot, ear.

The largest measurements in mm. were as follows:—

		Head & body.	Tail.	Ear.	Hind foot.
Mus norvegicus.	♂ ad. No. 250 ...	253	233	22	43
" "	♀ ad. No. 215 ..	225	204	19	41
Mus r. tectorum.	♂ ad. No. 203 ...	188	232	24	35·5
" "	♀ ad. No. 181 ...	190	232	24	36·5
Mus r. alexandrinus.	♂ ad. No. 290 ...	199	220	26	35
" "	♀ ad. No. 287 ...	195	208	26	35

[These measurements are given only as showing the greatest sizes attained; they are those of individuals and in no sense average measurements, so that, for instance, it must not be assumed that the ears of *M. alexandrinus* are on the average larger than those of *M. tectorum*. Owing to the difficulty of accurately estimating the age of any individual, it is impossible to give average measurements.]

The proportionate lengths of the body and tail measurements were found to vary in both species, but in *M. norvegicus* the tail never exceeded the body length, and in *M. rattus* the tail was always longer than the body length.

The most reliable measurement therefore on which to make comparisons and the only one which dealt with a structural feature and for that reason admitted of least error, was that of the hind foot. This measurement may therefore be taken as a fair criterion of general size and as forming a good and reliable index for comparison.

Curves of this measurement were made, and on referring to that of *Mus rattus* (Table I., text fig. 58), we note that the male

Text-fig. 58.

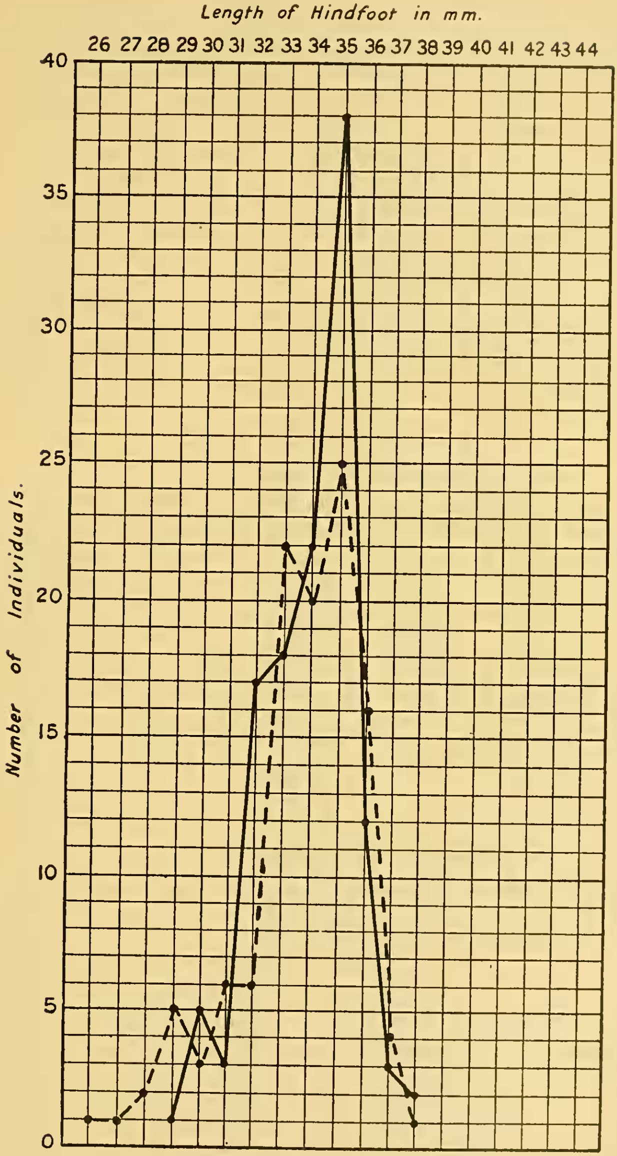

TABLE I.

Curve of hind-foot measurements of *Mus rattus* (all forms).

The dotted line represents measurements of the males.

curve (dotted line) shows three apices at 29, 33, and 35 mm., and that the female curve shows an apex at 30 and 35 with a break in continuity between 32 and 34; that is to say, both sexes show three apices, and that therefore a larger number of rats have hind feet of those three measurements than of the intervening sizes. Now, as these measurements include rats of all ages, and as there is no reason why there should be more of one particular age than another, seeing that the breeding season is fairly continuous throughout the year, it follows that we have here three 'limits of growth,' or, in other words, that certain individuals reach their limit of size at these three points, and consequently that the numbers at these points tend to accumulate and thus to form the apices in the curve. Those who accept Mendel's theory would here maintain, and probably with justice, that each apex represents a mutation, and that around these mutations fluctuating variations would occur so that, unless closely examined, the whole series would appear as a case of continuous variation.

Text-fig. 59.

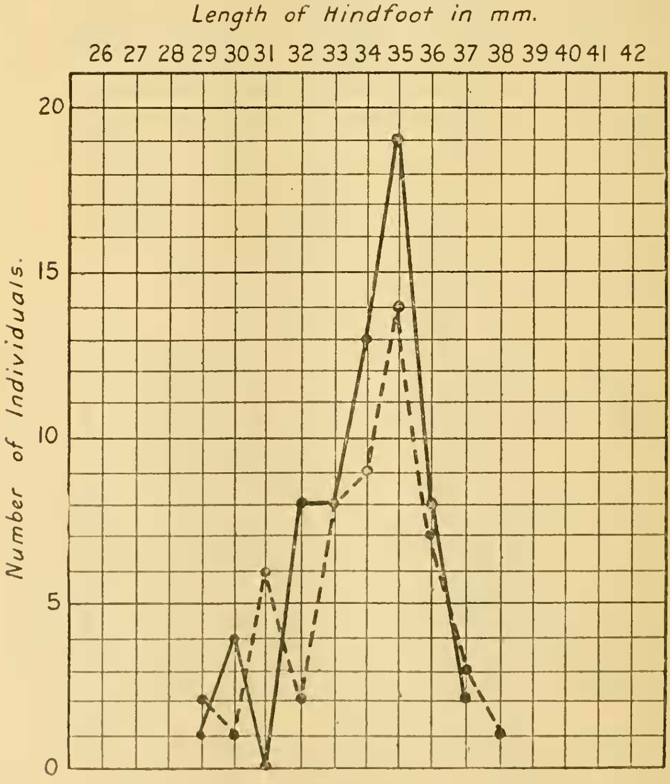

TABLE II.

Curve of hind-foot measurements of *Mus rattus tectorum* (Groups I. & II.)

Text-fig. 60.

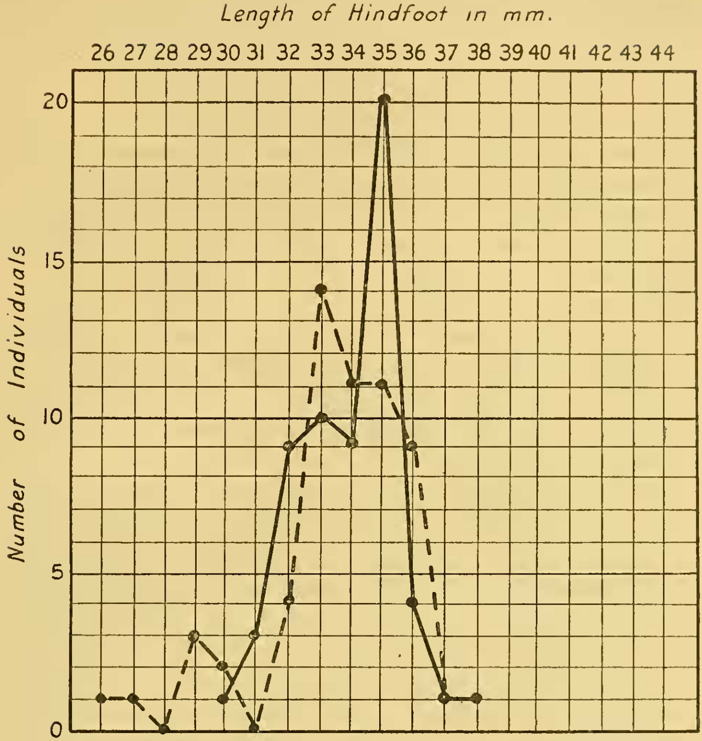

TABLE III.

Curve of hind-foot measurements of *Mus rattus alexandrinus* [Groups iii. & iv.].

(N.B.—Tables II. & III. are represented together in Table I.)

Tables II. and III. (text-figs. 59 & 60) show the curves of *M. r. tectorum* and *M. r. alexandrinus* taken separately. In the first table I have included all the rats which would fall under groups (i.) and (ii.), and in the second those included in groups (iii.) and (iv.) (see *ante*, p. 655).

The *tectorum* males show apices at 31 and 35 mm. with a slight check at 33, and the females at 30 and 35 with a slight check at 32–33. In *alexandrinus* the males show apices at 29 and 33 with a slight check at 35, and the females a slight apex at 33 with a large one at 35. There were no females of *alexandrinus* below 30, which accounts for the absence of the first apex.

This comparison makes it very clear that the apices in the general curve (Table I., text-fig. 58, p. 657) are not merely due to accident, but that the middle one at 33 represents the variety known as *alexandrinus*, and the largest one at 35 represents the white-bellied *tectorum*. The fact of the curves in Tables II.

and III. showing traces of the other apices, does not invalidate the reasoning as groups (ii.) and (iii.) are intermediate forms.

Mus rattus.

Comparison of Indian and Egyptian Forms.

The next question to arise is, what is the significance of the third and smallest apex at 29 and 30 mm. On reference to my paper quoted above in which I had divided *M. rattus* into three subgroups, we find the hind-foot measurements as follows:—

Jalorensis	subgroup,	hill form.	Hind foot	30 mm. (29–31·5).
Rufescens	,,	tree form.	,,	33 mm.
Griseiventer	,,	house form.	,,	35 mm.

These measurements, it will be noted, correspond exactly to the three apices in the curves of the Egyptian rats; so that we are, I think, justified in considering the small apex at 29 to represent the hill form (*Jalorensis* subgroup) of the Oriental Region, but which has become, in the level country of Egypt, unrecognisable externally.

This is a point which is of extreme importance from a deeper and more general point of view, for here, in a low-lying country, we have traces of a variety which in another part of the world has become the predominant form in the hills. Now, if continuous variation were the only method of evolution, we should find that in a level country all variations suitable to the hills would be eliminated, so that, in course of years, no trace of them would remain as they would be swamped by the more suitable forms, but apparently this has not happened in the present instance. The small-footed variety is still present in Egypt, permeating the race, and still existing in sufficiently strong numbers to spring up again quickly and become a dominant form should it ever find itself under suitable conditions.

Although, perhaps, not absolutely conclusive, this affords considerable evidence that the three subgroups of *M. rattus*, which I first differentiated in 1903 and which are strongly confirmed by the present work, probably arose as mutations.

There is yet a further point. One of the characters of the *Jalorensis* subgroup (the hill form) is the pure white hairs of the underparts. In this case it is associated with a small hind foot, but in Egypt we find it in *M. tectorum*, which has the largest hind foot of the three forms. It is therefore evident that the colour of the underparts is a character which has not always been inherited in connection with the size of the foot, but may occur in any one of the subgroups, so that in one country it may be characteristic of the hill form, in another of the tree form, and so on *.

* I am aware that on the evidence so far brought forward it might be argued that, if the colour of the underparts is not always found in correlation with the same sized hind foot, it is a character of but little use in distinguishing the sub-

Comparison of M. rattus *and* M. norvegicus.

Passing now from *M. rattus* to *M. norvegicus* and comparing Tables I. (text-fig. 58, p. 657) and IV. (text-fig. 61), we find a striking and surprising analogy in the curves. As in the case

Text-fig. 61.

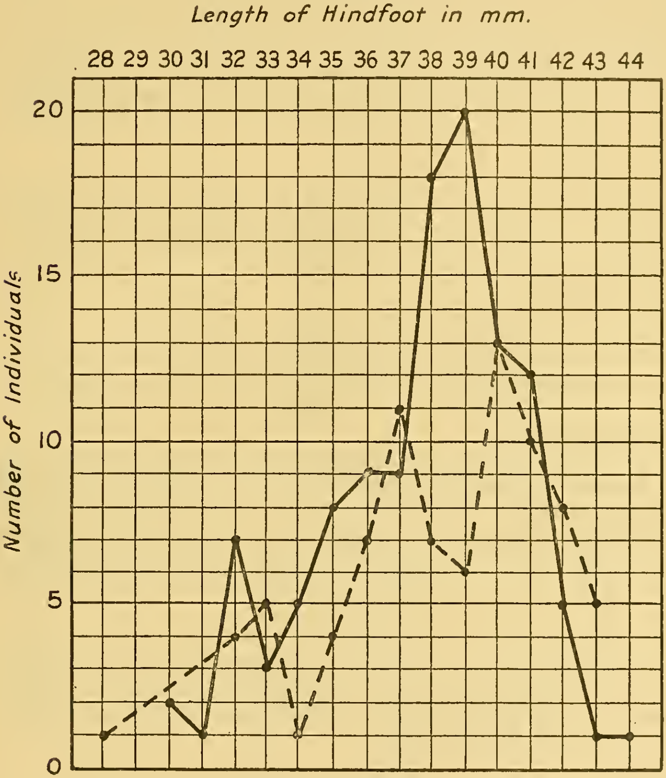

TABLE IV.

Curve of hind-foot measurements of *Mus norvegicus.*

of *M. rattus*, *M. norvegicus* also shows three apices at 32, 37, and 39, but in this case there is no colour variation, and therefore no

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groups, for being a separate mutation it might be found (if the hind-foot measurement were taken as the determinant character of the subgroup) in two or more of the subgroups.

The answer to this objection according to our *present* knowledge is that in any particular locality we have always found it associated with one, *and only one*, size of hind foot; that is to say, always in the same subgroup as defined by the size of the foot. Furthermore the breeding experiments, so far as they have gone, seem to point to the fact that it *is* inherited in correlation with the size of the hind foot in the rats from Egypt.

means of individually distinguishing the different forms or mutations, as we may now, I think, call them.

Here, therefore, in an entirely different species we find the same mutations present, and whereas in the case of the one (*M. rattus*) we are enabled to distinguish easily the various forms owing to the combination of the hind-foot character with a colour character, yet in the other species (*M. norvegicus*) we are unable to subdivide it into three forms, owing to the impossibility of definitely detecting which character is present in any particular individual. Nevertheless we have cognisance of characters (mutations) which cannot be recognised by any external inspection of individuals, although we have proved their presence beyond a doubt.

It would of course be rash to be too positive, yet it is extremely unlikely that these rats tend in any way to pair according to their foot character. If the characters were therefore merely individual variations, they would undoubtedly tend to be swamped and an even curve would result. This, however, is not the case. [For purposes of comparison we have added (Table V., text-fig. 62) a curve of the hind foot of *Acomys cahirinus*; this, it will be noted, is a perfectly simple curve with only one apex. As the number of *Acomys* measured (about 100) was nearly the same as the number of *M. alexandrinus*, the comparison is a perfectly fair one.]

We have here, therefore, in *M. norvegicus* a splendid example of a Mendelian character (mutation) being carried on unimpaired through generations; and there can be little doubt that if these animals found themselves under certain conditions where small feet, for example, prove of great advantage, very few generations would suffice for the small-footed race to become the dominant form.

The Mendelian theory enables us to understand how a small-footed race could be produced in a very short time, or how, if that favourable mutation were not present, the species might die out before the cumulative effects of Natural Selection on continuous variation would have time to act.

General Notes.

Much work of value still remains to be done by enquiry into the gradual formation of species, and these rats offer a wide field for the study of minute variations. Many groups of the smaller rodents as, for example, rats of the *Mus jerdoni* group and many of the Oriental groups of squirrels, offer similar problems of great complexity. In the former case we have numbers of very closely allied forms all inhabiting the same district, and each form has, apparently, its representative in other neighbouring districts. Systematists of late years have been content to burden each of these forms with a different name and there to leave the matter. Such work, necessary as it may be, can be but a preliminary step, and unless the subject is pursued further, the chaos brought about by a multitude of names is worse than the old plan by which one name was made to cover all varieties.

More recently still, the rediscovery of Mendel's theory has, at

Text-fig. 62.

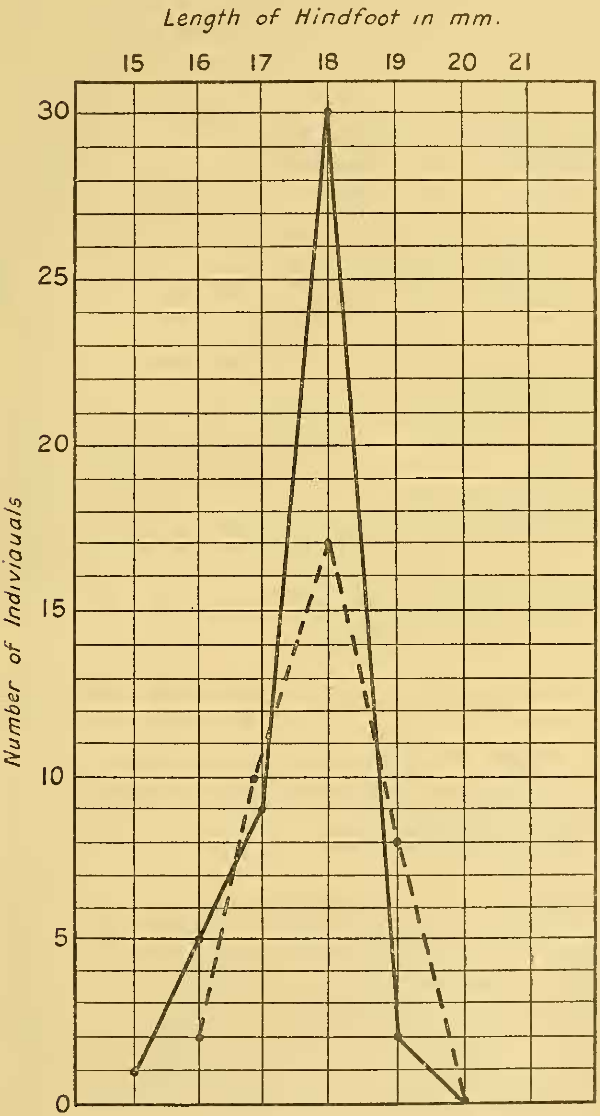

TABLE V.

Curve of hind-foot measurements of *Acomys cahirinus*, to show simple curve for comparison with previous Tables.

least, given a working hypothesis on which we may attempt to solve some of the problems of heredity; and though I am far from admitting that Mendel's law is the sole, or even the chief, factor governing heredity, it does undoubtedly help us to understand how these closely allied forms can either (i.) exist in the same locality as distinct varieties, or (ii.) in another locality become apparently lost although a closer inspection shows them to be present, only waiting for a suitable environment in which to develope.

To prove this matter further, it becomes necessary to conduct Mendelian experiments on these varieties. This I have begun to do on a small scale. The experiments are, however, as yet in the initial stages and no definite results can be stated. So far as they have gone, we find that pure *M. tectorum* mated with pure *M. tectorum* have produced pure *M. tectorum*. Pure *M. alexandrinus* when paired together have also bred absolutely true. A pair of grey *M. tectorum* (group ii.) showing slight traces of brown on the feet produced young like themselves (group ii.) and grey *M. alexandrinus* (group iii.).

As far as it goes, therefore, this evidence seems to further confirm the fact that *Mus rattus* should not be regarded as a species in which variation has run wild, but rather as a species containing certain definite mutations, which when mated together breed perfectly true. From its wandering habits and prolific breeding much intercrossing takes place, giving rise to these innumerable varieties, but no better evidence could be had of the purity of the gametes than the fact that when the apparently pure races are mated together (even when captured amongst a mixed crowd) they breed absolutely true.

Summary.

The main points that have been brought out in this paper are as follows:—

(i.) Two varieties (and intermediates) of *M. rattus* are found in Egypt.

(ii.) The hind foot is taken as a standard measurement and curves of this measurement drawn.

(iii.) These curves show three apices, the first being very small.

(iv.) These three apices correspond with the length of the hind foot typical of the three subgroups of *M. rattus* in the Oriental Region described by myself some years ago.

(v.) Hence it is argued that these three apices probably represent *mutations*, and that the first and smallest apex represents the *Jalorensis* subgroup found in the Oriental Region, but which from some cause or other is practically non-existent in Egypt.

Since, however, a *mutation* cannot be destroyed, we still find it in a small percentage of individuals ready under favourable circumstances to increase.

It is pointed out that this may account for the very quick way in which some species accommodate themselves to altered surroundings, since if a favourable mutation is present in the species very few generations would suffice to make it the dominant form.

(vi.) In *M. rattus* we found that the length of the hind foot was also correlated with external differences, and that the white-bellied *M. tectorum* had a longer hind foot than the darker *M. alexandrinus*.

Although in the Oriental Region the pure white underparts is characteristic of one of the subgroups, yet in that region it is correlated with a different sized hind foot to that with which it is associated in Egypt. Therefore the length of the hind foot and the colour of the underparts, although both pure mutations, can probably be inherited independently.

(vii.) An examination of the hind-foot curve in *M. norvegicus* shows also three apices, but in this case there is no colour-character by which the mutations may be distinguished externally. The length of the hind foot as a mutation is therefore a character common to two or more species.

(viii.) It is suggested that this enables us to understand how several very nearly allied forms of the same species (e. g. in *Mus jerdoni* and some of the Sciuridæ) may exist in the same locality without losing their characteristic differences, however small those differences may be.

(ix.) Further investigation on these lines is required by means of experiments in heredity, and so far as the author has carried these out the pure varieties of *M. tectorum* and *M. alexandrinus* were found to breed perfectly true.

(x.) Lastly, this paper claims to show that *Mus rattus* is a species containing many slight but definite mutations which, as far as the evidence goes, breed true when paired together, and that the apparent innumerable and indefinite variations are merely due to these animals being carried all over the world and mixing together in the large seaport towns.

In short:—The varieties in *Mus rattus* appear to run on definite lines and to have arisen as mutations, they are therefore inherited on Mendelian lines. Of the three main varieties found in the Oriental Region only two occur in Egypt, but this paper shows the presence of the third, though in very small numbers. One of the characters of these varieties is shown to be present in another species, *M. norvegicus*, although it cannot be distinguished in any particular individual. It is further hinted that many of these so-called species which are very closely allied have probably arisen as mutations, and that it is due to this fact that they are able to exist side by side under precisely the same conditions and yet preserve their characters intact. It may also be noticed that the colour-character of the hairs on the underparts is also found in another species, namely, the house-mouse, *Mus musculus*. *M. m. gentilis* has the hairs white to their bases, while *M. m. orientalis* has slate-coloured bases. Both these forms occur in Egypt.